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A RECORD OF FOURTEEN OIL WELLS AT BRADY'S BEND, ARMSTRONG COUNTY, PENNSYLVANIA.

BY. J. P. LESLEY.

(Read before the American Philosophical Society, Phila., Nov, 1st, 1872.)

Having recently requested Mr. Persifor Frazer, Assistant Professor of Chemistry in the University of Pennsylvania, to examine for new estimates of quantity the coal areas which have escaped erosion, in the country on the two sides of and closely adjoining the Allegheny River, at the remarkable ox-bow bend in its course, 70 miles above Pittsburgh and 60 miles below Oil City ; he brought back with him a MSS. report of of the wells bored by the company on the river banks and along the beds of the ravines descending to it from the west. We owe this report to the kindness of Stephen Halbrook, Esq., Superintendent of the Brady's Bend Iron Works.

It is needless to recapitulate the history of the oil discoveries, and the gradual extension of the oil producing districts from Titusville and the line of Oil Creek eastward to the Tidioute district, southeastward to the Clarion, westward to French Creek, and southward via Oil City, Franklin, Parker's Landing, and Brady's Bend, to the neighborhood of Butler, where the last discovery excitement is now raging. It is only necessary to refer to my report on the geological grounds for believing the middle Allegheny River districts to be productive oil country, published in the Proceedings of this Society, in 1865.* In that paper I have sufficiently described the *locale* of the wells now to be described. These records may also be compared with similar records communicated to the Society and published in its Proceedings of April, 1865.

The "Engineers' Datum" of the following table is an assumed level, *one hundred feet lower* than a mark made on the Brady's Bend Iron Company's warehouse, on the river bank, showing the extreme height reached by the great and disastrous freshet of March 17, 1865.

No.	Height of well mouth above Eng. datum.	Depth of well.	Depth below river, highest water mark.	First yield in barrels per day.	Present yield per day.
1..	96 feet.	?	?	?	1 bbl.
2..	232	1,400	1,268		<i>no sand rock.</i>
3..	97.62	1,111	1,113	5 + bbls.	1 bbl.
4..	97.69	1,262	1,264		<i>abandoned.</i>
5..	100.31	1,105	1,105	7 bbls.	2 bbls.
6..	300.48	1,290	1,090	5½ bbls.	4 bbls.
7..	437.41	1,414	1,077	9 bbls.	8 bbls.
8..	379.18	1,345	1,066	840 bbls.	150 to 200 bbls.
9..	101.38	1,065	1,066	4½ bbls.	3 + bbls.
10..	330.27	1,300	1,070	1 bbl.	<i>abandoned.</i>
11..	111.13	1,200	1,189		<i>powerful gas blow.</i>
12..	216.50	1,212	1,095½	12 bbls.	13 bbls.
13..	426.38	1,402	1,076	3 bbls.	2 bbls.
14..	359.89	?			<i>to be sunk to 4th sand.</i>

* See Proc. A. P. S., vol. 10, p. 61.

From the above table, it appears that all the oil-producing wells mentioned in it get their supply from one stratum lying in an undisturbed and horizontal position, varying in their actual depths below a fixed datum level from 1,113 to 1,066 feet, a difference of only 40 feet. This difference is due to three causes, viz. :—1. The different depths in the oil-bearing stratum penetrated by the bottom boring of the wells ; 2. The slight inequalities in the upper surface of the stratum ; 3. And chiefly, to a general slight dip of the rocks, both from the northwest and from the southeast, in towards the centre line or axis of the trough or basin which here crosses the Allegheny River in its northeast-southwest course ; and also to a still slighter and almost insensible decline of the axis of the basin itself southwestward.

The table also confirms what was proven years ago, long before the fact was acknowledged by oil men, namely, that it makes no difference whether a well is started in the valley bottom or on the hill tops, provided it goes down to the uniform and nearly horizontal oil-bearing sandrock. For some of these wells have their mouths at elevations more than 300 feet greater than others. Some on the river bank, and others high up at the heads of side ravines. The great No. 8 well was commenced at an elevation (379—96=) 283 feet higher than those on the river bank which yield only from one to three barrels a day.

The following table shows the thickness of the third sandrock where it was passed entirely through :

No. 2.—No sandrock found and no oil.

No. 4.—Sandrock, 26 feet ; hard fine white sand.

No. 5.—Sandrock, 27 feet ; fine pebbles.

No. 6.—Sandrock, 16 feet ; with slate partings.

No. 7.—Sandrock, 27 feet ; pebbles pretty coarse.

No. 8.—Sandrock, very coarse and open.

No. 9.—Sandrock, pebble very fine and close, very little gas.

No. 10.—Sandrock, 10 feet ; pebbles pretty fine, except in one thin streak.

No. 11.—To sandrock, no oil, but great gas blow, doubtless from a fissure.

No. 12.—Sandrock, 17 feet, all pebbles ; steady flow of oil.

No. 13.—Sandrock, 13 feet ; coarse open pebbles ; and a fair amount of gas.

No. 14.—Sandrock, 13 feet ; large coarse pebbles ; fair amount of gas. Other noteworthy facts are as follows :

No. 1 well, on the river bank, one half mile above the rolling mill, begun March, 1865, finished 1866.

No. 2 well, at the mouth of Cove Run, May, 1866—June, 1870.

No. 3 well, on the river above the mill, commenced August, 1868—pumping in September, 1872, 1 barrel a day.

No. 4 well, on the river above the mill, May, 1869—March, 1870. Cost \$10,405. Record of strata given below.

No. 5 well, on the river above the mill, June, 1869—April, 1870. At 931 feet struck so powerful a gas vein, that the bore-hole was deluged with water and abandoned for four months. In June, 1871, a three quart nitro-glycerine torpedo was exploded without increasing the production of oil. The pebble rock was almost as fine as sea-sand.

No. 6 well, on Queenstown Run; August, 1870—April 5, 1871; drilled with the water cased out; all the previous wells were drilled in water; casing commenced at 357 feet; not much gas.

No. 7 well, on Queenstown Run; August 7, 1870—March 1, 1871; water cased out at 512 feet; some gas at 1,050; commenced pumping about 9 barrels a day, and has produced up to September 7, 1872, 4,133 barrels.

No. 8 well, on Queenstown Run; June 26, 1871—September 22, 1871; water cased out; first show of oil September 22, and began to fill up very slowly. At 12.35 A. M., September 23, struck a vein of gas and oil which spouted over the top of the derrick, and was fired by the night lamp hung in the derrick, burning the rigging down. The spouts occurred every two minutes. At 9 A. m. the fire was extinguished and the oil began to fill the tank at the rate of 35 barrels an hour, but gradually calmed down to about 60 barrels a day during the first month, and October 22 ceased to flow. Tubeing and sucker rods were then put in, and she began to flow again at the rate of 150 barrels a day.

This well has been cleaned out many times to keep her in good running order. Immediately after any one such cleaning she produces from 70 to 90 barrels a day, and gradually falls off to about 20 to 25, when it is understood that she again needs cleaning. In fifty weeks she has produced 9,505 barrels. There is not much gas except when flowing.

No. 9 well, on the river opposite Catfish; June 24, 1871—October 24, 1871; water cased out; cost \$5,750.

No. 10 well, on Lower Campbell Tract; July 10, 1871—May 22, 1872; water cased out. After passing through third sand at 1,300 feet, put in a 4 quart torpedo, which seemed to have very little effect. Sand pumped for two days afterwards and found that she filled up with less than a barrel of oil per day, and therefore concluded it was useless to tube her. Not much gas at any time.

No. 11 well, on river half mile below the mill; August 24, 1871—June 24, 1872; water cased out at 437 feet. Struck very heavy vein of gas at 858 feet.

The gas from this well, by calculation, would supply fuel to run the rolling mill and machine shop boilers, being therefore equal to 100 tons of coal per week.

The pressure of gas would sometimes lift the tools 20 or 30 feet in the hole, tools weighing 1,700 pounds and rope 300 pounds. The flow of gas is enormous and continuous.

No. 12 well, on Queenstown Run; December 9, 1871—April 12, 1872; water cased out at 394 feet. Struck heavy vein of gas February 2, at

725 feet, which caused a flow of water until March 1, when casing was put in and the water stopped off.

Struck oil at the top of third sand April 4, at 1,183 feet, the rock being nearly all good pebble rock; after passing through it (1,200 feet) drilled 12 feet into slate for a pocket; tubed well April 12; commenced pumping 12 barrels a day, and the well is now doing 13 barrels. Much gas all the time. Cost \$6,557.

No. 13 well, on Queenstown Run; January 2, 1872—May 8, 1872; water cased out at 290 feet. Best show of oil at 1,390. Cost \$6,671.

No. 14 well, on Queenstown Run; June 11, 1872—September 2, 1872; water cased out at 227 feet. Little oil in third sand; will push it deeper.

It only remains to give vertical sections of the Measures passed through, premising, that the Great Conglomerate No. XII, the base rock of the Coal Measures forms the low cliffs at water level in the river valley; all the hills being built up of the nearly horizontal Lower Coal Measures or Allegheny River System, and the underground of Sub-Carboniferous and Devonian.

The following records of wells No. 4 and No. 5 of the foregoing description were made from labels on sample bottles, marked daily by the well drillers, and are not supposed to be perfectly reliable, but are nevertheless for the most part accurate notations of the character of the Sub-carboniferous and Upper Devonian Measures penetrated in reaching the oil-bearing strata.

RECORD OF OIL WELL NO. 4.

Struck the "mountain sandrock" at a depth of 50 feet.

Got through it at.....	240 feet.
Grey sand at.....	898 "
Grey sand at.....	933 "
Grey sand at.....	940 "
Dark gray sand.....	944 "
Black slate.....	947 "
Dark rock.....	952 "
Dark rock.....	955 "
Gray sand.....	965 "
Slate rock.....	976 "
Black rock.....	992 "
Black sand.....	998 "
Grey sand.....	1,008 "
Grey sand.....	1,003 "
Blue sand, hard.....	1,005 "
Black sand, hard.....	1,008 "
Blue sand, pretty hard.....	1,012 "
Slate rock.....	1,015 "
Hard sand.....	1,038 "
Sand.....	1,085 "

Sandrock.....	1,100 feet.
Red sandstone.....	1,126 "
Black sand.....	1,140 "
Grey sand.....	1,141 "
Grey sand.....	1,143 "
Mud.....	1,144 "
Blue slate.....	1,145 "
Soft slate.....	1,146 "
Soft slate.....	1,147 "
Shelly.....	1,148 "
Slate.....	1,150 "
Slate rock.....	1,152 "
".....	1,162 "
".....	1,165 "
Shelly rock.....	1,172 "
Slate rock.....	1,176 "
".....	1,181 "
".....	1,183 "
".....	1,191 "
Blue slate.....	1,194 "
".....	1,197 "
Shelly rock.....	1,211 "
Traces of oil.....	1,220 "
Slate.....	1,235 "
Slate rock.....	1,248 "
Dark slate.....	1,252 "
Slate—well abandoned at.....	1,260 "

RECORD OF WELL NO. 5.

Struck the mountain sandrock at.....	45 feet.
Got through it at.....	215 "
Grey sand.....	350 "
Slate rock.....	400 "
".....	440 "
Soft slate rock.....	460 "
Grey rock.....	490 "
Slate rock.....	510 "
Slate shells.....	530 "
Slate rock.....	560 "
".....	580 "
".....	620 "
Shell rock.....	640 "
Slate rock.....	660 "
".....	670 "
".....	690 "
".....	710 "

Sandrock.....	715 feet.
“.....	720 “
“.....	730 “
Slate rock.....	745 “
Red rock.....	750 “
Pebble rock.....	775 “
Sandrock.....	779 “
“.....	780 “
“.....	790 “
Slate rock.....	795 “
Sandrock.....	805 “
<i>Red rock—</i>	
Grey sand.....	808 “
Sandrock.....	812 “
“.....	815 “
“.....	820 “
“.....	822 “
“.....	824 “
“.....	826 “
<i>Red rock—</i>	
White sand.....	825 “
Rock.....	830 “
“.....	840 “
Grey sand.....	844 “
“.....	847 “
“.....	848 “
Sandrock.....	850 “
Blue rock.....	855 “
Sandrock.....	860 “
Black sand.....	865 “
Sandrock.....	896 “
“.....	930 “
<i>Red rock—</i>	
Sandrock.....	939 “
“.....	940 “
“.....	941 “
“.....	943 “
Shelly rock.....	948 “
“.....	951 “
“.....	954 “
Slate Rock.....	965 “
Red rock.....	972 “
Hard sand.....	986 “
Soft sand.....	998 “
Dark rock.....	1,018 “
Red sandrock.....	1,026 “

Slate.....	1,050 feet.
Shelly rock.....	1,055 "
THIRD SAND rock.....	1,073 "
Sandrock.....	1,076 "
".....	1,078 "
Slate and shelly.....	1,084 "
Pebble rock.....	1,085 "
".....	1,090 "
Sandrock.....	1,092 "
" Tubed well.....	1,100 "

and began pumping about 7 barrels in 24 hours.

It is a pity that the above records are so defective. The intervals between the numbers given are in many cases large and not noted, and must not be taken as the *thicknesses* of the rocks named.

There is, however, a positive value in all such records, however defective, as may be noted by the recurrence of the *red rocks* in the above lists. These may define the position of the great red formation of the Palæozoic series No. IX of the Pennsylvania State Survey, the representative of the Old Red Sandstone of English geologists, and the Catskill Formation of the New York geologists.

In Well No. 4 it is noted once only as being struck at 1,126 feet.

In Well No. 5 it appears at 750, 805, 826, 930, 972 and 1,026 feet.

The thickness of the Conglomerate No. XII is accurately determined in Well 4 at 190 feet, and in Well 5 at 170 feet.

The thickness of the Conglomerate No. XII in the salt well 45 miles further down the river, as determined (not with entire accuracy) from the Record, published on p. 65, vol. X., of the Proceedings A. P. S., April 1865, is $494\frac{1}{2} - 334\frac{1}{2} = 160$ feet; or, if the top of XII be placed at the "White Sand" $440\frac{1}{2}$ and all the "Gray Sandrocks" be included down to $666\frac{1}{11}$, $= 220$ feet.

At Sligo Furnace on the Clarion (p. 63, vol. X.), the Conglomerate No. XII, seems to be only 117 feet thick, soft red slate of XI under it only 3 feet thick, and the red and blue slates of IX lie $786 - 183 = 603$ feet below its base, or 720 feet below its top.

The resemblance of this to the record of Well No. 5, given above, is very observable. Thus, in Well No. 5, the red rocks of IX are first struck at $750 - 45 = 715$ feet beneath the top of the Conglomerate.

In the Sligo Well (15 or 20 miles to the northeast of it), the top of the red rocks is $786 - 66 = 720$ feet beneath the top of the Conglomerate.

In the Well No. 5, the redrocks are noticed at intervals from 750 to $1026 = 276$ feet.

In the Sligo Well, the red rocks occupy an interval of only 118 feet.

It must be taken into consideration, however, that the lowest red rocks of the well No. 5 may represent not No. IX, but the Red Beds of VIII, described in my report to Professor H. D. Rodgers, in 1841, and published in his Final Report of the Geology of Pennsylvania, under the

head of the Geology of the Wellsborough Valley or Tioga River District in Tioga County. To trace the thinning away of these calciferous and ferriferous red beds of VIII (Lower Devonian) on their way towards Ohio, underground, is one of the desiderata of American geology.

Other well-boring records are published on pages 227 ff, vol. X, Proc. A. P. S., but most of them are confined to the Coal Measures. Those on p. 238 ff, however, penetrate the Devonians to considerable depths and show the red rocks in positions analogous to those described above.

In one well, at the head-waters of the Clarion, the mouth of the well being 370 feet below a coal bed, and also below the bottom of XII, the red rocks of IX (?) occur from 216 to 415 — an interval of 200 feet, which is about the normal thickness of IX in this zone of its decrease westward. The Manchester (Tioga river) red beds (?) were struck at intervals from 925 to 956 = 41 feet, *i. e.*, with an interval of 510 between their top and the bottom of IX.

In the Glade Well near Pithole (page 241, vol. X), in the Oil Creek country, the red slates were first struck at 196 and got through at 318, the interval being 122 feet. Some red shale was then struck near the well bottom (abandoned, no oil) at 612, *i. e.*, 294 feet below the bottom of the upper red shales.

These also probably represent IX and the Manchester red beds, with a diminished interval due to westing.

These red rocks correspond to the Marshall group of Michigan, of Winchell (Proc. A. P. S., vol. XI., p. 74), the Gritstone redrocks above and the Chocolate shales below (the latter just over the Hamilton) in Ohio (Idem, p. 75), and to the Brown shales of the Keokuk group of Indiana. They are very noticeable to the traveller on the railways crossing Northern Ohio.

NOTE.—I have received the following letter of explanation respecting the wells at Brady's Bend :

ST. LOUIS, MO., *November 13, 1872.*

Dear Sir :—The detailed surveys were begun and mostly made under my direction, and the wells Nos. 6, 7, 8 and 9 were located by me. This would be of no interest to you or the public were it not that the location of these wells was the result of a long, carefully pursued, and at least apparently successful investigation into the laws of the distribution of the oil in the "sandrocks."

You had already shown that these rocks existed there and at what depth, and had also shown that the general stratigraphy of the district rendered it reasonably certain that oil would be found there, and this had been confirmed by the results of boring in the case of two of the five wells sunk.

I tried to find the law of distribution in its application to narrower limits, so as to decrease to the utmost the risks, and increase to the utmost the chances in sinking wells.

Of the five sunk before I went there, two were productive ; of the four sunk since I left, one is productive ; of the four I located, namely, Nos.

A. P. S.—VOL. XII.—3T

6, 7, 8 and 9, all are productive. No. 9, which is the least productive of the four, was located under restriction to the Lower Campbell tract. No. 8, the most productive, was the last one I located without restriction. Nos. 6 and 7 were both down before any other well was started in the Whiskey Run or Queenstown Run field. The same principles which guided the locating these wells, led me to advise the Brady's Bend Iron Company against trying the Upper Campbell tract, and the results of boring there by other parties have confirmed their correctness, and there have been so many confirmations that my confidence in the principles amounts to conviction.

In opening the Whiskey Run or Queenstown Run field, I simply followed the general line of strike from the Armstrong Run field; but in locating individual wells I sought lines and areas of deposition of coarse pebbles in the "sandrocks" out of broken condition of the "sandrocks."

I had not so far completed the research into the laws which govern the direction and position of these lines and areas that I felt free to communicate them when I left the oil country, but hope to push the investigations further hereafter. Meanwhile it may be of some interest that the above results have followed an effort pursued by scientific methods to find and apply such laws.

Yours, very respectfully,

JAMES E. MILLS,
Vice President Big Muddy Iron Company.

Stated Meeting, November 15th, 1872.

Present, nine members.

Vice-President, Mr. FRALEY, in the Chair.

A photograph of Mr. H. M. Phillips was received for insertion in the Album.

Letters accepting membership were received from Mr. Isaac Norris, Jr., dated Philadelphia, October 31st, 1872, and from Mr. A. J. Cassatt, dated 2030 Delancey Place, Philadelphia, November 6th, 1872.

Letters of acknowledgment were received from the Smithsonian Institution (Proc., No. 78), and the Nat. Verein at Bremen (87), September 7th, 1872.

Donations for the Library were reported from the St. Petersburg Observatory; Antiquarian Society at Copenhagen; R. Academy at Berlin; German Anthropological Society; Museum of Natural History at Paris; Paris Anthropological Society; Annales des Mines; Revue Politique; Nature; L. & H. S. Quebec; Boston S. N. H.; Yale College;